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# INDUSTRIAL RESEARCH INSTITUTES:
## Their Role in the Application of Appropriate Technology and Development

## MALAYSIA:
## Small-Scale Brick Manufacturing

Ronald P. Black, A. Rahim Bidin,
Woo Seng Khee, and Nik Ahmad Kamil

A series prepared by the
University of Denver
Denver Research Institute
Office of International Programs
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# FOREWORD

This case history has been written to assist development planners, personnel of industrial research institutes, and USAID mission personnel in understanding the role that IRIs can and do play in the application of technology to development. This case history is one in a series of eight prepared by the Denver Research Institute under the sponsorship of USAID/Office of Science and Technology (contract AID/ta-C-1337).

The cases in this monograph series first appeared in another DRI publication, Appropriate Technology for Development: A Discussion and Case Histories, edited by Donald D. Evans and Laurie Nogg Adler (Boulder, Colorado: Westview Press, 1979). This book was sponsored by the USAID Office of Science and Technology in preparation for the United Nations Conference on Science and Technology for Development (UNCSTD).

# INTRODUCTION

## INDUSTRIAL RESEARCH INSTITUTES

In many countries the creation of a viable indigenous industrial sector has long been considered one of the key elements to economic development. Consequently, an industrial research capability is of significance in defining the industrial needs and priorities of a country or region and matching them with appropriate technologies. An industrial research institute (IRI) has been defined as a technical organization established to make direct contributions to industrial development in the private and public sectors[1]. In this context an IRI differs from private research entities which have no proclaimed mandate or responsibility in the practical application or adaptation of technology to their countries' development needs. Frequently industrial research institutes are in some manner government funded and are therefore closely allied to the economic, social and political climate of that government. Ideally, IRIs play a supporting role in the design and implementation of national policies that reflect economic development and growth, while functioning autonomously. In reality, however, government usually plays a substantive role in research institute operations. In any case, compatibility and cooperation among government agencies should be preserved, and selection of industrial research programs should reflect needs of both the public and the private sector.

In many instances, the IRI acts as liaison between government and industry. Ideally and particularly in less developed countries (LDCs), the IRI acts as an intermediary in determination of the need for and the subsequent creation, adaptation or transfer of technology. In fact, the study of technological opportunities or the choice of appropriate technology for development is one of the major functions of the industrial research institute.

In comparison to other technologies, appropriate technology represents the social and cultural dimensions of innovation[2]. As a mediator in an innovation process, a research institute's task is to identify the real needs of the local community, develop or introduce technologies and organizational means which can meet these needs and initiate a process of development based on the internal innovative forces of the local community[3]. In this manner, the IRI addresses the issue of appropriate technology and its role in the development process.

However, opportunities for innovation do exist in areas other than just industrialization--increasing agricultural productivity, developing

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[1] United Nations. Industrial Research Institutes, United Nations Publication No. E.70.II B.21. New York: UN, 1970, p. vii.

[2] Nicolas Jequier, Appropriate Technology: Problems and Promises. Part I, The Major Policy Issues, 1976, Development Centre of the Organization for Economic Cooperation and Development (OECD). p. 9.

[3] Ibid., p. 36.

rural technologies, and offering incentives for small industrial projects are also duties that a research institute is likely to perform.

The methods by which IRIs assess technological choice and stimulate innovation are varied. Most often development strategies would include a combination of the following:

- Survey, study and develop uses for local raw materials.
- Develop new processes and improve existing ones.
- Develop new products and recognize new uses for existing ones.
- Improve industrial and agricultural productivity.
- Study the technological and socioeconomic feasibility of industrial and agricultural projects.
- Develop standards and specifications.
- Determine choice of technology and scale of operation.
- Determine industrial location and site.
- Conduct marketing research[4].
- Acquire and disseminate scientific and technological information.
- Systems design and management of development programs.
- Evaluate a chosen technology and its relationship to local economic and cultural traditions.

To establish solutions to identifiable problems, the research institute often adapts foreign technologies to suit local conditions and offers incentives to small industries to create new technologies. Technological innovation is accomplished in a variety of ways from actual adaptation of a chosen technology to training of researchers and engineers for institution building and infrastructural support, to establishment of extension services to help define and fulfill needs.

The creation of linkages between research institutes has allowed increased communication and the transfer of information and technologies, not only between developed and developing countries, but among developing countries as well. In a few instances, regional research

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[4] United Nations. Proceedings of the Interregional Seminar on Industrial Research and Development Institutes in Developing Countries, Beirut, Lebanon, 30 November-11 December, 1964. Vol. 1, New York: UN, 1966. p. 45.

institutes or networks of institutes have been established to facilitate development in common geographic and cultural areas. (ICAITI in Guatemala representing Central America is such an example.) Similarly, an international IRI organization called WAITRO (World Association of Industrial and Technological Research Organizations) has been created.

Industrial research institutes tend to become the foci for national S&T development and have offered essential infrastructural support. Research institutes, therefore, may play a very important role in mapping the future economic growth and development of a country. With this increasing responsibility, an IRI's task becomes more complex and difficult, particularly when original development goals are overwhelmed by other considerations. Factors such as politics, financial risk, societal or cultural considerations, legal restrictions, staffing problems, marketing problems, fear of change, and sheer inertia may impede or block the transfer process and thus weaken or negate its economic effect[5].

## CASE HISTORIES

Much can be learned about development from the investigation and analysis of industrial research institutes. The Office of International Programs (OIP) at the Denver Research Institute (DRI) has initiated linkage activities with a variety of research institutes worldwide over the last decade under the sponsorship of USAID's Office of Science and Technology. Through these linkage activites, choice and adaptation of technology, training of researchers and engineers, exchange of information and help in the management of research institute affairs have occurred. A dynamic process of communication has been established through DRI's relationship with each research institute, and much knowledge has been gained about the development process by all those involved.

Realizing the value of imparting research institute experiences to others in the development field, DRI has gathered several case histories of industrial research institutes' endeavors in the area of technology transfer. The cases were collected for the most part by OIP staff (often assisted by IRI colleagues) who acted as impartial reporters when collecting the information. The goal of the research was not to select cases that showed only successful adaptation of technology, but to show ways and means by which IRIs must operate to encourage and achieve progress in the development scheme. There are, in fact, examples where a transfer of technology is considered unsuccessful or unsatisfactory.

The case Malaysia: Small-Scale Brick Manufacturing, written by Ronald P. Black, A. Rahim Bidin, Woo Seng Khee, and Nik Ahmad Kamil, describes a typical, small-scale brick factory. The future challenges that the industry may have to face are related by the factory

[5] James P. Blackledge, The Industrial Research Institute in a Developing Country: A Comparative Analysis. Washington, D.C.: USAID, 1975. p. 19.

owner. For a different perspective, an industry forecast from an expert at the Standards and Industrial Research Institute of Malaysia is presented.

# MALAYSIA: SMALL-SCALE BRICK MANUFACTURING

Ronald P. Black, A. Rahim Bidin,
Woo Seng Khee, and Nik Ahmad Kamil

## INTRODUCTION

Malaysian brick manufacturing was initiated in the early part of the twentieth century. From the outset, old rubber trees were used as a source of fuel for firing bricks. While this is still the practice, one small-scale brick manufacturer recently raised a question as to whether this practice would remain viable much longer.

## BACKGROUND

### Small-Scale Brick Manufacturing Firms in Malaysia

These firms provide bricks for partitioning in Malaysia's home and building construction industry, which has been growing rapidly. Based on data provided by the Malaysian Department of Statistics for 1974, the authors estimate the current brickmaking industry for Peninsular Malaysia[1] to be a M$ 50 million-per-year business.[2]

In Malaysia, companies that produce more sophisticated decorative brick, as compared to the small-scale brick manufacturers, do exist. According to a preliminary survey of the Standards and Industrial Research Institute of Malaysia (SIRIM), the decorative brick companies provide about 2 percent of the total number of bricks produced in Malaysia.

The decorative brick manufacturing companies are much more capital intensive than the "common" brick firms. According to the SIRIM survey, a typical decorative brick factory would cost ten times more than a common brick

[1]Peninsular Malaysia excludes primarily Sarawak and Sabah on Borneo.

[2]One U.S. dollar is equal to approximately M$ 2.2.

factory. The decorative brick factories are more automated and quality conscious than the common brick factories and use diesel fuel for firing bricks.

## Rubber Trees in Malaysia

Rubber trees were introduced in Malaysia during the nineteenth century. Rubber is now the country's number one foreign exchange earner--currently representing 23 percent of Malaysia's export revenues. Malaysia now produces 47 percent of the world's natural rubber.

Rubber trees are replanted every twenty to twenty-five years. This is encouraged by the Malaysian government through a subsidy to planters for acreage replanted. This subsidy remains in effect until the new trees begin to produce. In 1975, Peninsular Malaysia had 1.4 million acres planted in rubber trees. Reportedly, 3 percent of all Malaysian rubber trees are felled each year.[3]

Over the last several years, the number of acres planted in rubber trees has decreased slightly as a result of shifts to palm oil production. Recently, however, the government has begun to explore tax incentives and other measures that may halt these shifts.

Wood from old rubber trees in Malaysia originally was used for fuel. At present, it also is used for producing charcoal, wood chips, and blockboard (see Table 1 for amounts used in 1974).

TABLE 1
USES FOR OLD RUBBER TREES

| Use | Amount (tons) |
|---|---|
| Cooking | Unknown |
| Brick kilns and smokehouses | 2,000,000 |
| Charcoal | 1,000,000 |
| Wood chips | 300,000 |
| Blockboard | 10,000-20,000 |

Source: "Utilization of Rubber Wood," pp. 1-2.

## A SMALL-SCALE BRICK MANUFACTURER

Eng Huat and Company is typical of small-scale brick manufacturers in Malaysia. It is family owned and managed

[3]Tan Ah Goh and Chang Wai Pong, "Utilization of Rubber Wood for SMR Pallet Construction" (Shah Alam Selangar, Malaysia: Sirim, 1974), p. 1.

and has been in existence for about twenty years. Raw materials must now be brought to the company site, located in suburban Kuala Lumpur. In its early days, however, the site was surrounded by rubber trees; the clay used for the bricks was obtained from nearby deposits. These materials have long since been depleted.

When the plant was visited by the authors in early 1979, Mr. Yap, a young company manager, was pleased with the current success and future prospects of the business. While he envisioned developments that would require changes for Eng Huat, he seemed confident that these could be met successfully.

## Facilities

Eng Huat and Company, together with the family residence, is situated on three acres of land. Office activities are conducted in the home.

For transporting clay from the pits to Eng Huat, the company has two five-ton trucks, one a 1974 Bedford, the other a 1970 Mercedes. Each cost about M$ 40,000. The company also has a 1960 Michigan bulldozer that is used for moving and mixing the different types of clay. The bulldozer cost approximately M$ 100,000. Fifteen wheelbarrows are used for moving the bricks; each wheelbarrow cost M$ 100.

The company also owns a locally made, screw-type extruder that is more than ten years old. The extruder can process clay for approximately 20,000 bricks in an eight-hour shift. Its present power source is a forty-horsepower Lister diesel engine of about the same age as the extruder. It is located in a room near the extruder and uses eight gallons of diesel fuel per eight-hour shift. Attached to the extruder is a manual wire cutter that cuts the clay into bricks. The cutter produces ten bricks at one time.

The extruder, cutter, and diesel engine are located under a shed that measures approximately 35 by 150 feet. The shed also is used for drying and storing the "green," or unfired, bricks. The shed is constructed of local materials. It has a roof of galvanized zinc sheets, and its sides are open.

The two kilns used by the company are ten years old, which is the normal lifetime of a kiln (see Figure 1 for a sketch of one of the kilns). The kilns are constructed of the type of bricks produced by Eng Huat. The kilns measure fifteen feet in height, forty feet in length, and twenty feet in width, and the wall thickness is three feet. The top of the kiln is open. Along the length of the kiln, on both sides, are eight firing holes, two feet by two feet, into which rubber tree wood is fed for fuel. The kilns are located under an open-sided shed that has a galvanized zinc roof.

Process

Eng Huat and Company produces approximately 300,000 bricks per month of a quality acceptable to Malaysian building contractors for partitioning walls in houses and other buildings (see Figure 2 for a schematic diagram of the process used for producing these bricks).

The two company trucks obtain clays from pits located within five miles of the business. The clays are dumped about two hundred feet from the shed containing the extruder. The front-lift bulldozer then does the preliminary mixing of the clays and brings them, as needed, to the extruder shed. These subsequently are shoveled into a box approximately ten feet square located over the extruder. Here the clays are mixed, if necessary, to give the bricks their desired characteristics. Water is added to give the mixed clay a suitable moisture content for shaping by the extruder.

In the center of the box is an opening for the extruder's hopper, into which the mixed, moistened clay is shoveled. The extruder shapes and forces a rectangular column of clay from its mouth. The clay column then moves across a table to three persons who operate the manual wire cutter.

The green bricks are then manually carried by three persons from the cutting table to another part of the shed, where they are stacked for drying by two other workers. The green bricks are allowed to dry for three days and are then ready for loading in the kiln.

The green bricks are hand carried to the kiln, where they must be stacked in a pattern that allows for easy transmission of heat throughout the kiln. Although many stacking patterns are possible, Yap uses the one that his family has always employed. The bricks are stacked to a height of approximately twelve feet, a process that requires about four days and eight workers and that produces approximately 100,000 bricks.

Firing the bricks requires about seven days. Approximately six days of low-intensity firing are needed to gradually remove moisture from the bricks, followed by one day of intense firing. Yap can tell when the intense firing should begin by observing the smoke from the kiln. When the smoke ceases, intense firing should commence. The time required for low-intensity firing is determined by the moisture content of the green bricks.

During the low-intensity firing, rubber tree wood is fed into each of the kiln's firing holes every six hours. This is

FIGURE 1
ENG HUAT KILN

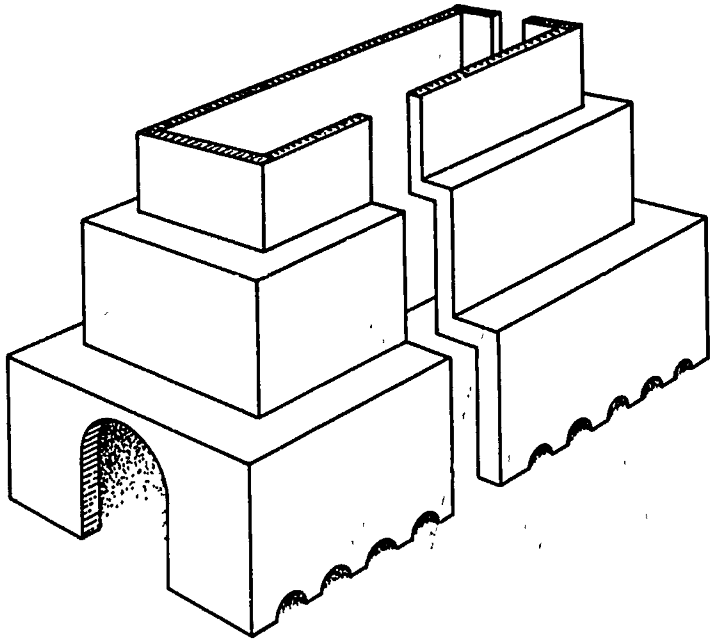
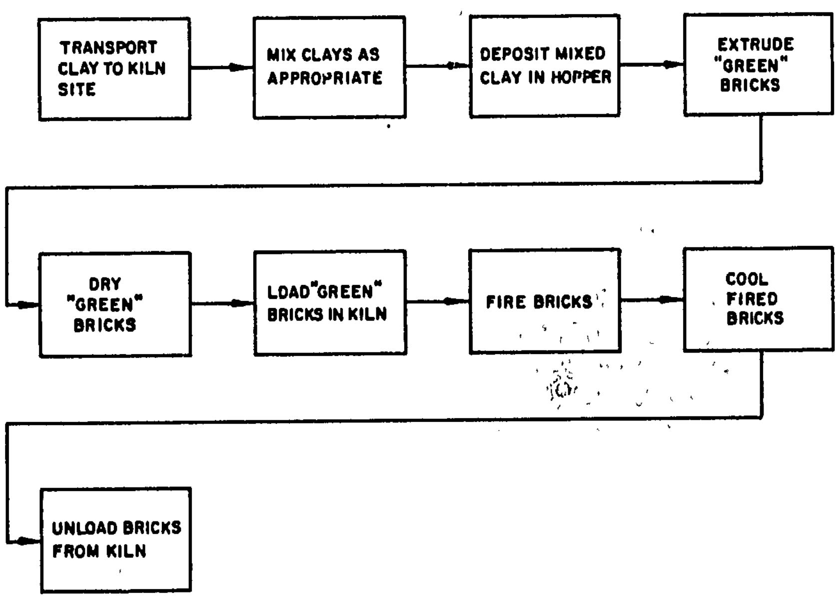


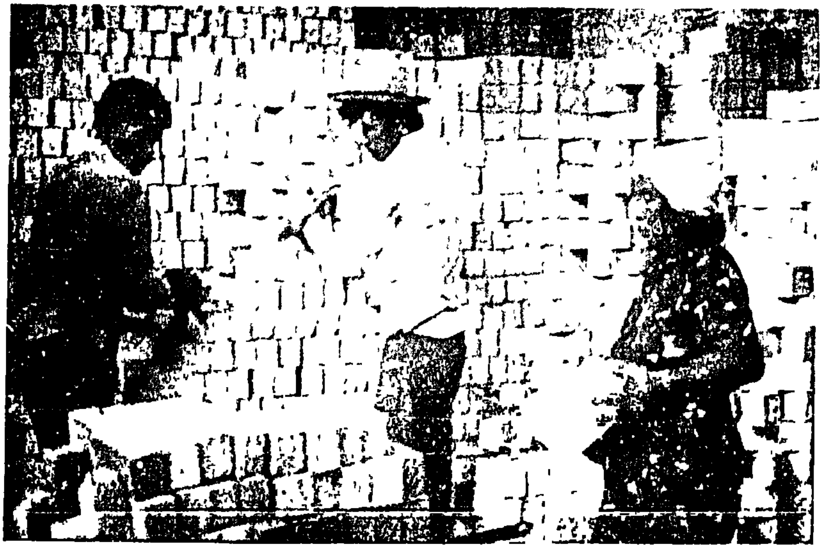
FIGURE 2
BRICKMAKING PROCESS AT ENG HUAT



Shed covering brick kiln

normally done by two persons. When intense firing begins, fuel is added every thirty minutes, requiring a team of four persons.

Finally, the kiln must cool for two days before the workers can begin to unload the bricks. This usually is done directly into a purchaser's truck by about five persons. Unloading takes one to five days depending on the number of workers. Five persons can unload a kiln in about two days.



Stacking bricks after firing

## Fuel

Eng Huat uses primarily old rubber tree wood as fuel. Occasionally other scrap woods are used, but Yap prefers rubber tree wood because it provides a more consistent heat.

The rubber tree wood is purchased from dealers who collect it within a thirty- to forty-mile radius of Eng Huat, then deliver it to the company. For one kiln firing, approximately twenty-five truckloads of the wood are required. Each load weighs about three tons and costs about M$ 60.

Although old rubber tree wood has been the traditional fuel for small-scale brick manufacturers in Malaysia, Yap says that it is getting increasingly difficult to obtain. He believes that within five years he will have to shift to a petroleum-based fuel that will cost more and that will require a kiln of a different and more expensive design.

## Personnel

Yap and his brother manage the company's operations. Eng Huat hires two truck drivers, one bulldozer operator, two persons for shoveling the clay, three persons for cutting the clay into bricks, three workers for carrying the green bricks to where they are to be stacked for drying, and two persons for stacking the green bricks. The two truck drivers and bulldozer operator receive between M$ 400 and M$ 500 per month. The other workers are paid on a piece basis. The ten-person team is paid M$ 50 for each 10,000 stacked green bricks.

Eng Huat contracts for the work associated with the firing operation. Yap pays M$ 80 for 10,000 fired bricks. The staffing pattern for brick firing seems to vary considerably depending on the availability of workers. However, based on discussions with Yap and his brother, a typical pattern is estimated to be as follows: (1) loading the kiln--eight persons working one shift for four days; (2) low-intensity firing--two persons working three shifts for six days; (3) intense firing--four persons working three shifts for one day; (4) cooling--none; and (5) unloading the kiln--five persons working one shift for two days. Therefore, the firing operation is estimated to provide 13.5 person-months of employment each month. This figure is based on obtaining an average of three firings per month from the two kilns.

Yap noted that it is getting increasingly hard to find workers; therefore, he has thought about automating parts of his operation. He said that his first step probably would be to purchase a fork lift.

Yap expressed the opinion that the increasing difficulty in finding workers was due to the growing number of work opportunities in the Kuala Lumpur area. Not only are more places hiring workers, but a wider variety of types of businesses are offering employment opportunities. According to Yap, many of these jobs are more attractive than working as a manual laborer in a brick factory.

## Market

Eng Huat sells bricks directly to building contractors. Because of the current construction boom in Malaysia as a whole and in Kuala Lumpur in particular, Yap notes that he easily can sell all the bricks he can produce. He does not advertise; contractors come directly to him to buy the bricks.

Yap said that several years ago Eng Huat exported bricks to Singapore because a better price could be obtained there. However, in the mid-1970s the Malaysian government passed a regulation preventing the exportation of bricks because of the brick shortage in the Malaysian construction industry.

At present, Eng Huat receives M$ 0.08 to 0.10 for each brick depending on its quality. Since the company sells about 300,000 bricks per month, its annual sales volume reaches approximately M$ 324,000.

## Finances

According to Yap, capital costs for setting up a brick factory similar to Eng Huat would total M$ 1,268,500 (see Table 2). Monthly operating expenses for Eng Huat are M$ 12,654 (see Table 3).

Because Eng Huat and Company owns all of its facilities and consequently has no loan to pay off, its monthly profits can be estimated at approximately M$ 14,000.

To calculate the funds that an investor would need to create a job place in a small-scale brickmaking factory in Malaysia, several assumptions were made. First, such a factory would not be established on property as valuable as the land on which Eng Huat is located. For approximately M$ 90,000, three acres of cleared land may be obtained twenty-five kilometers out of Kuala Lumpur. This would be

TABLE 2
CAPITAL COSTS FOR BRICK FACTORY
SIMILAR TO ENG HUAT

| Requirement | Number | Price (M$) |
|---|---|---|
| Land | 3 acres | 1,000,000 |
| Office/residence | 1 | 15,000 |
| Trucks | 2 | 80,000 |
| Bulldozer | 1 | 100,000 |
| Extruder | 1 | 15,000 |
| Diesel engine | 1 | 15,000 |
| Shed | 1 | 2,000 |
| Kiln | 2 | 40,000 |
| Wheelbarrows | 15 | 1,500 |
| | TOTAL | 1,268,500 |

TABLE 3
MONTHLY OPERATING EXPENSES FOR ENG HUAT

| Requirement* | Cost (M$) |
|---|---|
| 300 truckloads of clay @ M$ 8 per load | 2,400 |
| 300 gallons of fuel for trucks @ M$ 1.20 per gallon | 360 |
| Wages for two truck drivers | 900 |
| Wage for bulldozer operator | 450 |
| Fuel for operating extruder | 144 |
| Wages for workers producing and stacking green bricks | 1,500 |
| Contract for firing bricks | 2,400 |
| Rubber tree wood | 4,500 |
| TOTAL | 12,654 |

*Based on a production output of 300,000 bricks.

a more likely location for a new brickmaking factory than inside metropolitan Kuala Lumpur.

Second, a used bulldozer, costing approximately one-half the price of a new one, would be purchased to move the clay. Third, it is assumed that a loan could be obtained to cover 60 percent of the capital investment costs and that payments on the loan would not commence until the factory was making an income.[4] Finally, it is assumed that the new factory would need the equivalent of two months' operating expenses.

Based on the preceding assumptions, an investor in a small-scale brick manufacturing operation in Malaysia would need about M$ 100,000. Assuming the staffing pattern described earlier, one job place could be created by an investor for about M$ 8,000.

## A SIRIM PROJECTION[5]

The building industry in Malaysia is growing at 8.4 percent per annum, and this trend is expected to continue into the 1990s. Brick, being a major component of building construction in the country, is expected to be produced with an output growth rate approximating that of the building industry. Other materials, such as concrete blocks, boards, wooden planks, and concrete panels, can compete with bricks, but they are not expected to pose a serious threat. The relative costs and convenience, as well as the availability of clay throughout Malaysia, favor the continued use of clay bricks. Only concrete panels and cement blocks can completely substitute for bricks. Wooden planks and boards can be substituted for bricks only in certain applications, such as partitioning walls that are constructed internally and where soundproofing and other properties possessed by bricks are not required.

The use of cement blocks and concrete panels depends on the availability and accessibility of cement. The current cement supply in Malaysia just about meets the demand. The cost of manufacturing Portland cement is dependent upon the cost of fossil fuel, namely oil. And the cost of oil is expected to continue to climb due to the depletion of the world's oil reserves. Furthermore, investments for cement

[4]According to a loan officer at a local bank, these are both reasonable assumptions.

[5]For the purposes of this case study, the SIRIM staff projected the outlook for the brick industry and the use of rubber tree wood as a fuel source in Malaysia. The SIRIM projection is contained in this section.

plants are high. As a result, it is not expected that the supply of cement will increase dramatically in the near future. Switching from bricks to cement blocks in building would cause a severe shortage of cement in Malaysia and thus constrain the increased production of cement blocks. The continuing use of bricks therefore seems assured.

Most of the bricks produced in Malaysia are fired in kilns that use rubber tree wood as a fuel. A surplus of rubber tree wood exists in Malaysia today, even though the supply is restricted in parts of the more developed areas of the country. Old rubber trees are continually cut down to make way for new rubber trees; this is expected to continue. The government recently has tried to encourage a greater use of land for the planting of rubber trees; this should help to ensure a continuous wood supply.

A small percentage of bricks produced in Malaysia today is being fired by oil-fueled kilns. These bricks are used mostly for decorative purposes and cost a great deal more than the common bricks. The price of decorative brick is expected to increase as the price of oil rises. It is also expected that the price of bricks fired by rubber tree wood will increase but at a slower rate than the cost of oil-fired bricks. The price of common bricks will rise gradually because of inflation and also because rubber tree wood is being used increasingly as a fuel by many industries that do not want to pay the escalating costs of oil.

## CONCLUDING REMARKS

The common brick manufacturing industry in Peninsular Malaysia, 80 percent of which employs fewer than fifty persons at each factory, accounts for an annual M$ 50 million contribution to the gross domestic product of the country.[6] Assuming that Eng Huat and Company is typical (which SIRIM surveys support), then the industry provides jobs directly to approximately 4,500 Malaysians, most of whom are unskilled.

Bricks provide approximately a 5 percent value input to the construction industry. According to the SIRIM projection, if bricks were not available, the country would have to substitute cement. This, in turn, would cause a severe cement shortage.

Since old trees are a waste product of the rubber industry, their use as a fuel in firing bricks is valuable.

[6]See Survey of Construction Industries, Malaysian Government Department of Statistics, Kuala Lumpur, 1974. The figure for the annual contribution to the country's gross domestic product has been extrapolated from this report.

In addition, jobs are created and income is generated for the persons who cut and transport the 140,000 tons[7] of old rubber tree wood consumed by the brickmaking industry in 1979.

The use of rubber tree wood as a fuel for the brick-making industry in Peninsular Malaysia represents the replacement of 6.16 million gallons of heavy fuel oil. The difference in the cost of fuel alone is M$ 4,501,000.

As a result of this study, the SIRIM staff began to question whether the "typical" common brick factory in Malaysia is indeed the most "appropriate." Much of what Mr. Yap described to the team about his operation and facilities was based on "handed down" knowledge. The SIRIM staff began to question whether the facilities, particularly the kiln design, and the operations (for example, the pattern in which the bricks are stacked in the kiln), are optimum. As a result, SIRIM may initiate a new program to determine, scientifically, what is the most "appropriate" technology for common brick manufacturing in Malaysia.

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## PERSONS INTERVIEWED

Mr. Yap, manager, Eng Huat and Company

[7]This 1979 figure (estimated) is based on the amount of wood required for one kiln firing and the annual output of brick in Peninsular Malaysia.